CHAPTER 5b
Hand/Wrist Tendinitis

SUMMARY

Eight epidemiologic studies have examined physical workplace factors and their relationship to hand/wrist tendinitis. Several studies fulfill the four epidemiologic criteria that were used in this review, and appropriately address important methodologic issues. The studies generally involved populations exposed to a combination of work factors; one study assessed single work factors such as repetitive motions of the hand. We examined each of these studies, whether the findings were positive, negative, or equivocal, to evaluate the strength of work-relatedness, using causal inference.

There is **evidence** of an association between any single factor (repetition, force, and posture) and hand/wrist tendinitis, based on currently available epidemiologic data. There is **strong evidence** that job tasks that require a combination of risk factors (e.g., highly repetitious, forceful hand/wrist exertions) increase risk for hand/wrist tendinitis.

INTRODUCTION

Since the hand/wrist area may be affected by more than one musculoskeletal disorder, only those studies that specifically address hand/wrist tendinitis are considered here. Studies with outcomes described as hand/wrist disorders or symptoms in general, or those in which hand/wrist tendinitis was combined with epicondylitis, e.g., were excluded from this section because it was not possible to evaluate evidence for work-related hand/wrist tendinitis from the data. The eight studies referenced in Table 5 provided data specifically addressing hand/wrist tendinitis. In each of these studies the outcome was determined using physical examination criteria, although the case definitions varied among studies. Prevalence or incidence rates of hand/wrist tendinitis reported in these exposed groups ranged from 4% to 56%, and in unexposed groups from 0% to 14%. Such wide ranges of prevalence rates probably reflect the variability in diagnostic criteria as much as they do the range of workplace exposures in these studies. For example, one study used very strict criteria [Bystrom et al. 1995]. The case definition required observation of swelling along the tendon at the time of the physical examination. The only cases of tendinitis diagnosed were deQuervain's disease; no other cases of tenosynovitis or peritendinitis were diagnosed among 199 automobile assembly line workers. In contrast, the studies with the highest prevalence rates either did not clearly state what diagnostic criteria were used to determine the case definition, or the case definition considered recurrences of tendinitis new cases. Whether case definitions were inclusive or exclusive would not affect the relative risk (RR) as long as they were applied non-differentially between groups designated as exposed or unexposed.

Although several studies reported odds ratios, published data were reanalyzed and the results presented here and in Tables 5b1-3 as prevalence ratios (PRs). This was done because odds ratios may overestimate RR when prevalence rates are

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high, and to make estimates of RR comparable across studies. In studies that presented odds ratios in the original articles, the recalculation of data as PRs resulted in lower estimates of CI. In the one prospective cohort study [Kurppa et al. 1991] incidence rates and risk ratios are presented.

Except for the study reported by Armstrong et al. [1987], risk estimates were not reported separately for single risk factors. Only the Armstrong et al. study used a formal quantitative exposure assessment as the basis for determining exposure groups. Other studies grouped jobs with similar risk factors together and compared them to jobs without those risk factors. Typically, the selection of jobs for the exposed and unexposed groups was based on general knowledge of the jobs, previously published literature, or questionnaire data. Repetition, force, and extreme postures were considered in combination to determine which workers were exposed or unexposed. Formal exposure assessment, (such as videotape analysis for cycle time, repetition, extreme postures, and estimates of force) was usually conducted on a sample of jobs and used as rationale in the grouping of jobs into exposed and unexposed categories, rather than to create quantitative measures of risk factors. In some cases (e.g., Luopajarvi et al. [1979], investigators noted the difficulty in examining risk factors separately because of job rotation. For the purpose of this review, we have grouped study findings according to the risk factors present in the exposed job categories, based on the information in published articles. In Tables 5b1-3, studies are listed under single risk factors if there was evidence that the exposed and unexposed groups differed in that risk factor,

though the risk estimates mostly refer to combined exposures.

REPETITION

Definition of Repetition for Hand/Wrist Tendinitis

Armstrong et al.[1987] analyzed videotaped job tasks of a sample of workers, then divided job tasks according to level of repetitiveness: high repetition (cycle time <30 seconds, or >=50% of the cycle spent performing the same fundamental motions) or low repetition. Kuorinka and Koskinen [1979] created a "workload index" based on the number of pieces handled per hour multiplied by the number of hours worked, for a dose-response analysis within the exposed group. Comparison groups in the other studies were job categories; selection of the groups to be compared was based on observations, questionnaire data, or surveillance data.

Studies Reporting on the Association of Repetition and Hand/Wrist Tendinitis

Seven studies addressed repetition: Amano et al. [1988]; Armstrong et al. [1987]; Bystrom et al. [1995]; Luopajarvi et al. [1979]; Roto and Kivi [1984]; Kuorinka and Koskinen [1979]; and McCormack et al. [1990].

Studies Meeting the Four Evaluation Criteria

Two of the seven studies that addressed repetition met all four of the evaluation criteria: Armstrong et al. [1987], and Luopajarvi et al. [1979]. Armstrong et al. studied 652 industrial workers at seven manufacturing plants (electronics, sewing, appliance, bearing fabrication, bearing

assembly, and investment casting). Exposure assessment of jobs included videotape analysis and electromyography (EMG) of a sample of workers. Data from this assessment were then used to categorize jobs according to level of repetitiveness and force. Health assessment of workers focused on deQuervain's disease, trigger finger, tendinitis, and tenosynovitis. The hand/wrist tendinitis case definition required abnormal physical examination findings (increased pain with resisted but not passive motion or tendon locking with a palpable nodule, or a positive Finkelstein's test) in addition to meeting symptom criteria on standardized interviews. The PR for the high repetition/low force group (n=143) compared to the low repetition/low force group (n=157) was 5.5 (95% CI 0.7–46.3). The PR for the high repetition/high force group (n=157) compared to the low repetition/low force group (n=157) was 17.0 (95% CI 2.3–126.2). The effect of age, gender, years on the job, and plant were analyzed. A higher prevalence of tendinitis was noted among women but was not significantly associated with personal factors, whereas significant differences in posture were observed between males and females.

Luopajarvi et al. [1979] compared the prevalence of hand/wrist tendinitis among 152 female assembly line packers in a food production factory to 133 female shop assistants in a department store. Exposure to repetitive work, awkward hand/arm postures, and static work was assessed by observation and videotape analysis of factory workers. No formal exposure assessment was conducted on the department store workers; their job tasks were described as variable. Cashiers were

excluded, presumably because their work was repetitive. The health assessment consisted of interviews and physical examinations conducted by a physiotherapist (active and passive motions, grip-strength testing, observation, and palpation). Diagnoses of tenosynovitis and peritendinitis were later determined by medical specialists using these findings and predetermined criteria. The PR for tendinitis among the assembly line packers compared to the shop assistants was 4.13 (95% CI 2.63–6.49). Age, hobbies and housework were addressed and no associations with musculoskeletal disorders were identified.

Studies Meeting at Least One Criteria

Amano et al. [1988] reported the prevalence of cervicobrachial disorders, including tenosynovitis, among 102 assembly line workers in an athletic shoe factory and 102 age- and gender-matched non-assembly line workers (clerks, nurses, telephone operators, cooks, and key punchers). Exposure assessment was based on videotape analysis of the tasks of 29 workers on one assembly line. Assembly line workers produced about 3,400 shoes a day. All but one task had cycle times less than 30 seconds. No formal exposure assessment of the comparison group was reported. Diagnoses were determined by physical examination, including palpation for tenderness. The PRs for tenosynovitis of the right and left index finger flexors among the shoe factory workers were 3.67 (95% CI 1.85–7.27) and 6.17 (95% CI 2.72–13.97) respectively, compared to the non-factory workers. Tenosynovitis of the other digits was not diagnosed in the comparison group. Shoe assembly workers held shoe lasts longer in the left hand and had greater frequency of symptoms in the left hand. Comparison

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subjects were matched to shoe factory workers on gender and age (within five years).

Bystrom et al. [1995] studied forearm and hand disorders among 199 automobile assembly line workers and compared them to 186 randomly selected subjects from the general Swedish population. For both groups, exposure was assessed using rating scales on nurse-administered questionnaires that addressed daily duration of hand and finger movements, wrist position, grip, and hand tool use [Fransson-Hall et al. 1995]. Videotape analysis and electromyograms were conducted on a subgroup [Hagg et al. 1996]. A diagnosis of tenosynovitis or peritendinitis required the observation of swelling and pain during active movement on physical examination. A diagnosis of deQuervain's disease required a positive Finkelstein's test. No cases of tenosynovitis or peritendinitis, other than deQuervain's disease, were found in this study, probably because of strict clinical criteria used for the case definition. The PR for deQuervain's disease among the automobile assembly line workers was 2.49 (95% CI 1.00-6.23) compared to the general population group. Psychosocial variables and other potential confounders or effect modifiers were addressed by Fransson-Hall et al. [1995]. A higher prevalence of deQuervain's disease was noted among men than women.

Kuorinka and Koskinen [1979] studied occupational rheumatic diseases and upper limb strain among 93 scissor makers and compared them to the same group of department store assistants (n=143) that Luopajarvi used as a comparison group. Temporary workers and those with recent trauma were excluded from the scissor makers group. Exposure assessment included videotape analysis of scissor maker tasks. The time spent in deviated wrist postures per work cycle was multiplied by the number of pieces handled per hour and the number of hours worked to create a workload index. Cycle times ranged from 2 to 26 seconds; the number of pieces handled per hour ranged from 150 to 605. No formal exposure assessment was conducted on the shop assistants. Health assessment involved interview and physical examination by a physiotherapist following a standard protocol. Diagnoses of tenosynovitis and peritendinitis were later determined from these findings using predetermined criteria (localized tenderness and pain during movement, low-grip force, swelling of wrist tendons [Waris 1979]). In equivocal cases, orthopedic and physiatric teams determined case status. The PR for muscle-tendon syndrome among the scissor makers was 1.38 (95% CI 0.76-2.51) compared to the department store assistants. Whether or not cashiers were excluded from the comparison group in this study, as they were in the Luopajarvi et al. study is unclear. The study group was 99% female. No relationship was found between age- or body-mass index and muscle-tendon syndrome. The number of symptoms increased with the number of parts handled per year. Analyses of subgroups of scissor makers showed non-significant increased prevalence of muscle-tendon syndrome in short versus long cycle tasks and in manipulation versus inspection tasks. The authors noted a lack of contrast in exposures between the subgroups. A non-significant trend of increasing prevalence of diagnosed muscle-tendon syndrome with increasing number of pieces handled per year was noted in a nested case-control analysis (n=36).

McCormack et al. [1990] studied tendinitis and related disorders of the upper extremity among 1,579 textile production workers compared to 468 non-production textile workers, a reference group that included machine maintenance workers, transportation workers, cleaners, and sweepers. The textile production workers were reported as being exposed to repetitive finger, wrist and elbow motions based on knowledge of jobs; no formal exposure assessment was conducted. Health assessment included a questionnaire and screening physical examination followed by a diagnostic physical examination. The diagnosis of tendinitis required positive physical findings suggestive of inflammation. The textile production workers were divided into four broad job categories: boarding (n=296), which was noted to require forceful work as well as the repetitive hand-intensive work of the other categories; sewing (n=562); packaging (n=369); and knitting (n=352). The PR for tendinitis among all textile production workers was 1.75 (95% CI 0.9-3.39), compared to the reference group non-production textile workers. The PRs and 95% confidence intervals (CIs) comparing tendinitis among each broad category of textile production workers to the reference group are as follows: boarding – 3.0 (1.4, 6.4); sewing – 2.1 (1.0, 4.3); packaging – 1.5 (0.7, 3.5); and knitting – 0.4 (0.1, 1.4). The authors noted that the knitting work was more automated than the other textile production job categories. Race and age were not related to outcome, but the prevalence of tendinitis was higher in workers with less than three years of employment. Female gender was a significant predictor of tendinitis (p=0.01), but job category was a stronger predictor (p=0.001).

Roto and Kivi [1984] studied the prevalence of tenosynovitis among 92 male meatcutters compared to 72 male construction foremen. No formal exposure assessment was conducted. Meatcutters' work entailed repetitive physical exertion of upper extremities and shoulders. Construction foremen's work did not involve repetitive movements of the upper extremities. Health assessment was by questionnaire and physical examination. Tenosynovitis was defined as swelling, local pain, and finger weakness during movement. The prevalence of tenosynovitis among the meatcutters was 4.5%. The PR for tenosynovitis as defined by physical examination could not be calculated because there were no cases among the comparison group. The PR of tendinitis-like symptoms reported on the questionnaire among the meatcutters was 3.09 (1.43, 6.67) compared to the construction foremen. Serologic testing for rheumatoid arthritis was done to control for potential confounding, none was detected. Authors noted that tenosynovitis occurred in younger age groups.

Strength of Association—Repetition and Hand/Wrist Tendinitis

The PRs for repetitive work and hand/wrist tendinitis in the studies reviewed above ranged from 1.4 to 6.2:

Repetition and Hand/Wrist Tendinitis

PR and 95% CI	Authors	Exposed/Unexposed Groups
5.5 (0.7, 46.3) 17.0 (2.3, 126.2)	Armstrong et al. [1987]*	HI REP& LO FORCE / LO REP&LO FORCE HI REP&HI FORCE / LO REP&LO FORCE
3.7 (1.9, 7.3) to 6.2 (2.7, 14.0)	Amano et al. [1988]	shoe assemblers / clerks, nurses, operators, cooks, keypunchers
2.5 (1.0, 6.23)	Bystrom et al. [1995]	auto assemblers / general population
1.4 (0.8, 2.5)	Kuorinka and Koskinen [1979]	scissor makers / department store assistants
1.8 (0.9, 3.4)	McCormack et al. [1990]	textile production / maintenance workers, etc.
3.1 (1.4, 6.7)	Roto and Kivi [1984]	meatcutters / construction foremen
4.1 (2.6, 6.5)	Luopajarvi et al. [1979]*	food packers / department store assistants excluding cashiers

*Study met all 4 criteria.

In evaluating these RR estimates, study limitations should be considered in addition to statistical significance. Statistical significance addresses the likelihood that the results are not due to chance alone, whereas study limitations can bias the RR estimates in either direction. All of the PRs were greater than one, and four of the seven were statistically significant. The range (1.4-6.2) might reflect the level of contrast in repetitiveness between the exposed and comparison groups. For example, in McCormack et al. [1990], the comparison group consisted of machine maintenance workers, transportation workers, and cleaners and sweepers, whose exposure to repetition was not measured. If there were some exposure to repetitive work in the comparison group, then this would tend to decrease the RR for hand/wrist tendinitis among the textile workers. Another concern with this study is the possibility that the knitting workers may not have been exposed to very repetitive work due to greater automation in the knitting process. The effect of this potential misclassification of exposure would also be to decrease the RR.

Note that Kuorinka and Koskinen and Luopajarvi et al. both used the same

comparison group, but the number of subjects in the department store assistant group was 143 for Kuorinka and Koskinen, and 133 for Luopajarvi (who excluded cashiers from the comparison group). If Kuorinka and Koskinen did not exclude cashiers, this might tend to decrease the RR.

The highest RR (6.2) reported for repetitive work was by Amano et al. [1988]. In this study it is unclear whether the examiner was blinded to whether the subjects were shoe assemblers or in the comparison group of non-assembly line workers that included clerks, nurses, telephone operators, cooks, and key punchers. Because the occupational groups were examined on separate dates blinding seems unlikely. The lack of a clear case definition leaves open the possibility of examiner bias, which might lead to an increased CI. Alternatively, if there were a significant number of key punchers in the comparison group, who may have been exposed to repetitive work, that would tend to decrease the contrast in exposure and might lead to a decrease in the RR.

In summary, the potential for underestimation of the RR has been noted in studies where the RR is at the low end of the range, and the potential for overestimation of the RR has been noted at the high end of the range. Considering these concerns and statistical significance, the RR for hand/wrist tendinitis attributable to repetitiveness is probably more likely to be in the middle range of the estimates, based on the studies reviewed. The statistically significant estimates of RR in this middle group range from 2.5 to 4.1.

Temporal Relationship—Repetition and Hand/Wrist Tendinitis

All of the studies reviewed for this section were cross-sectional, so proving that exposure to repetitive work occurred before hand/wrist tendinitis is not possible. However, information in several of the studies suggests the likelihood that exposure to repetitive work occurred before the diagnosis of tendinitis. For example, recently employed workers were excluded by Kuorinka and Koskinen [1979]. In Luopajarvi et al.'s [1979] study group, the minimum length of employment was 3 years. In the McCormack et al. [1990] study, the minimum average length of employment in the job categories was more than 7 years. Bystrom et al. [1995] noted that subjects were selected for clinical examination 5 months after completion of questionnaires on exposure. Roto and Kivi's [1984] subjects had all worked in the food industry for more than one year. Armstrong et al. [1979] required a minimum length of employment of one year. Case definitions generally required that symptoms began prior to the current job or employment at the plant. This also suggests that exposure occurred before disease.

Consistency in Association for Repetition and Hand/Wrist Tendinitis

All of the studies reviewed showed positive RR estimates for hand/wrist tendinitis among occupational groups exposed to repetitive work, ranging from 1.4 to 6.2. Four of the seven studies resulted in statistically significant PRs. Considering only statistically significant estimates from studies not noted to have serious limitations (which might bias the RR), the range narrows to 2.5–4.1.

Coherence of Evidence for Repetition and Hand/Wrist Tendinitis

DeQuervain's disease and other tenosynovitis of the hand, wrist, and forearm have been associated for decades with repetitive and forceful hand activities as one of the possible causal factors [Amadio et al. 1995]. DeQuervain's disease is the entrapment of the tendons of the extensor pollicis brevis and abductor pollicis longus. Other similar conditions are trigger thumb and triggering of the middle and ring fingers, characterized by pain with motion of the affected tendon. Despite the fact that the tendon and its sheath may be swollen and tender, the histopathology shows peritendinous fibrosis without inflammation, and fibrocartilaginous metaplasia of the tendon sheath tissue. The role of inflammation early in the process is not clear [Hart et al. 1995]. As in carpal tunnel syndrome or epicondylitis, acute classical inflammation does not seem a critical pathophysiological component of the clinical condition, at least once it becomes chronic. Despite the observations that too much forceful and repetitive activity contributes to carpal tunnel syndrome and epicondylitis, the response of the tendons and the muscles to repetitive activity is likely that of a U-shaped curve. Too little and too much activity may be harmful, but intermediate levels of activity are probably beneficial. The studies of tendon and muscle physiology suggest that a certain amount of activity maintains the normal state of these tissues and leads to adaptive changes. These tissues have the ability to repair significant amounts of damage from some overuse; the poorly understood issue is when overuse exceeds the ability of the tissue to repair the damage or triggers a more harmful type of

damage [Hart et al. 1995]. Marras and Schoenmarklin [1991] reported that velocity and acceleration significantly predicted upper extremity musculoskeletal disorders (including tendinitis) among industrial workers performing hand-intensive job tasks.

Dose-Response Relationship For Repetition and Hand/Wrist Tendinitis

Kuorinka and Koskinen [1979] reported that within the group of scissor makers, increased prevalence of muscle-tendon syndrome occurred in short versus long cycle tasks and in manipulation versus inspection tasks. These increases were not statistically significant. The authors noted a lack of contrast in exposures between the subgroups. A non-significant trend of increasing prevalence of diagnosed muscle-tendon syndrome with increasing number of pieces handled per year was also noted in a nested case-control analysis (n=36) in the same study.

The Armstrong et al. [1987] data resulted in a PR of 17.0 (2.3, 126.2) for jobs that were highly repetitious and required highly forceful exertions. This suggests a synergistic effect when both risk factors are present because the estimate is greater than the sum of the RR estimate for force or repetition alone.

Conclusions on Repetition and Hand/Wrist Tendinitis

There is strong evidence for a positive association between highly repetitive work, in combination with other job risk factors, and hand/wrist tendinitis based on currently available epidemiologic data. All seven of the studies reviewed reported positive RR

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estimates. Four of these estimates were statistically significant. Potential confounders (factors associated with both exposure and outcome that may distort interpretation of findings) considered in the studies of hand/wrist tendinitis included gender, age, other medical conditions, and outside activities. There is no evidence that the associations reported here between repetitive work and hand/wrist tendinitis are distorted by gender, age, or other factors.

FORCE

Definition of Force for Hand/Wrist Tendinitis

Armstrong et al. [1987] based high and low force categories on electromyographs of forearm flexor muscles of representative workers. Comparison groups in the other studies were job categories; selection of the groups to be compared was based on observations, questionnaire data, or surveillance data.

Studies reporting on the Association of Force and Hand/Wrist Tendinitis

Five studies addressed force: Armstrong et al. [1987]; Bystrom et al. [1995]; Kurppa et al. [1991]; McCormack et al. [1990]; and Roto and Kivi [1984].

Studies Meeting the Four Criteria

One of the studies that addressed force met all four of the evaluation criteria: Armstrong et al. [1987]. Armstrong et al. studied 652 industrial workers at seven manufacturing plants (electronics, sewing, appliance, bearing fabrication, bearing assembly, and investment molding). Exposure assessment of jobs included videotape analysis and EMG of a sample of workers. Data from this assessment were then used to categorize jobs

according to level of repetitiveness and force. Health assessment of workers focused on deQuervain's disease, trigger finger, tendinitis, and tenosynovitis. The hand/wrist tendinitis case definition required abnormal physical examination findings (increased pain with resisted but not passive motion or tendon locking with a palpable nodule, or a positive Finkelstein's test) in addition to meeting symptom criteria on standardized interviews. The PR for the high force/low repetition group (n=195) compared to the low force/low repetition group (n=157) was 4.8 (95% CI 0.6–39.7). The PR for the high repetition/high force group (n=157) compared to the low repetition/low force group (n=157) was 17.0 (95% CI 2.3–126.2). The effect of age, gender, years on the job and plant were analyzed. A higher prevalence of tendinitis was noted among women, but was not significantly associated with personal factors, whereas significant differences in posture were observed between males and females.

Studies Meeting at Least One Criteria

Bystrom et al. [1995] studied forearm and hand disorders among 199 automobile assembly line workers and compared them to 186 randomly selected subjects from the general Swedish population. For both groups, exposure was assessed using rating scales on nurse-administered questionnaires that addressed daily duration of hand and finger movements, wrist position, grip, and hand-tool use [Fransson-Hall et al. 1995]. Videotape analysis and electromyograms were conducted on a subgroup [Hagg et al. 1996]. A diagnosis of tenosynovitis or peritendinitis required the observation of swelling and pain during active movement on physical examination. A diagnosis of deQuervain's disease required a positive

Finkelstein's test. No cases of tenosynovitis or peritendinitis, other than deQuervain's disease, were found in this study, probably because of strict clinical criteria used for the case definition. The PR for deQuervain's disease among the automobile assembly line workers was 2.49 (95% CI 1.00–6.23) compared to the general population group. Psychosocial variables and other potential confounders or effect modifiers were addressed by Fransson-Hall et al. [1995]. A higher prevalence of deQuervain's disease was noted among men than women.

Kurppa et al. [1991] conducted a prospective cohort study of tenosynovitis or peritendinitis (and epicondylitis) in a meat processing factory in Finland. Three hundred seventy-seven meat cutters, meat packers, and sausage makers were compared to 338 office workers, maintenance workers, and supervisors. Exposure assessment was based on previously published literature and knowledge of jobs at the plant. Job categories were selected based on whether or not strenuous manual work was required. The cohort was followed for 31 months. Health assessment consisted of physical examinations by plant physicians who were on-site daily, using predetermined criteria for diagnosing tenosynovitis or peritendinitis (swelling or crepitation and tenderness to palpation along the tendon and pain at the tendon sheath, in the peritendinous area, or at the muscle-tendon junction during active movement) and deQuervain's disease (positive Finkelstein's test). Incidence density rates (if a recurrence of tendinitis occurred after 60 days, it was considered a new case) for tendinitis were compared between each of the strenuous job categories and either the male or female comparison group of combined non-strenuous job

categories (office workers, maintenance workers and supervisors). The risk ratio for tendinitis among the meat cutters (100% males) compared to the male comparison group was 14.0 (5.7, 34.4); the risk ratio for tendinitis among the meat packers (79% female) compared to the female comparison group was 38.5 (11.7, 56.1); and the risk ratio for tendinitis among the sausage makers (86% female) was 25.6 (19.2, 77.5). A limitation of the study is the fact that the subjects were not actively evaluated for musculoskeletal disorders. Investigators relied on workers to seek medical care. This could result in a difference in case ascertainment between the exposed and unexposed groups because workers in non-strenuous jobs may not have sought medical care for musculoskeletal disorders since they might still be able to perform their jobs, whereas workers with MSDs in strenuous jobs might not be able to perform their jobs, and would be more likely to seek medical care. If subjects sought medical care, investigators were very likely to capture the information, even if medical care was provided outside the plant, plant nurses received and reimbursed the bills, and recorded the diagnosis and sick leave. However, when diagnoses were made by physicians outside the plant, diagnostic criteria were unknown; this occurred in 25% of the cases. Exposed and comparison groups were similar in age and gender mix, although gender varied with job.

McCormack et al. [1990] studied tendinitis and related disorders of the upper extremity among 1,579 textile production workers compared to 468 referents that included machine maintenance workers, transportation workers, cleaners, and sweepers. The textile production workers

were reported, based on knowledge of the jobs to be exposed to repetitive finger, wrist and elbow motions; no formal exposure assessment was conducted. Health assessment included a questionnaire and screening physical examination followed by a diagnostic physical examination. The diagnosis of tendinitis required positive physical findings suggestive of inflammation. The textile production workers were divided into four broad job categories. Boarding (n=296), was the only category noted to require forceful work. The PR for tendinitis among the boarding workers was 3.0 (95% CI 1.4–6.4), compared to the reference group. Race and age were not related to outcome, but the prevalence of tendinitis was higher in workers with less than three years of employment. Female gender was a significant predictor of tendinitis (p=0.01), but job category was a stronger predictor (p=0.001).

Roto and Kivi [1984] studied the prevalence of tenosynovitis among 92 male meatcutters compared to 72 male construction foremen. No formal exposure assessment was conducted. Meatcutters' work entailed repetitive physical exertion of upper extremities and shoulders. Construction foremen's work did not involve repetitive movements of the upper extremities. Health assessment was by questionnaire and physical examination. Tenosynovitis was defined as swelling, local pain, and finger weakness during movement. The prevalence of tenosynovitis among the meatcutters was 4.5%. The PR for tenosynovitis as defined by physical examination could not be calculated because there were no cases among the comparison group. The PR of tendinitis-like symptoms reported on the

questionnaire among the meatcutters was 3.09 (1.43, 6.67) compared to the construction foremen. Serologic testing for rheumatoid arthritis was done to control for potential confounding, none was detected. Authors noted that tenosynovitis occurred in younger age groups.

Strength of Association—Force and Hand/Wrist Tendinitis

Estimates of RR for hand/wrist tendinitis among those in jobs requiring forceful exertion range from 2.5 to 38.5:

The very large risk ratios reported by Kurppa et al. [1991] could be biased upward because of the difference in case ascertainment between the exposed and unexposed groups. Investigators did not actively evaluate subjects for musculoskeletal disorders (MSD), but relied on workers to seek medical care. As the authors noted, workers in non-strenuous jobs may not have sought medical care for MSDs since they might still be able to perform their jobs, while workers in strenuous jobs may not have been able to perform their jobs and would be more likely to seek medical care. This potential for differential case ascertainment between the exposed and unexposed groups undermines the credibility of the magnitude of the risk estimate.

Statistically significant estimates of RR for hand/wrist tendinitis among workers who perform strenuous tasks from the remaining studies range from 2.5 to 3.1.

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Force and Hand/Wrist Tendinitis

PR and 95% CI	Authors	Exposed/Unexposed Groups
4.8 (0.6, 39.7) 17.0 (2,3, 126.2)	Armstrong et al. [1987]*	HI FORCE&LO REP / LO FORCE&LO REP HI FORCE&HI REP / LO FORCE&LO REP
2.5 (1.0, 6.23)	Bystrom et al. [1995]	auto assemblers / general population
14.0 (5.7, 34.4) to 38.5 (11.7, 56.1)	Kurppa et al. [1991]	meat processors / office workers, maintenance workers, supervisors
3.0 (1.4, 6.4)	McCormack et al. [1990]	textile boarding workers / maintenance workers, etc.
3.1 (1.4, 6.7)	Roto and Kivi [1984]	meatcutters / construction foremen

Temporal Relationship—Force and Hand/Wrist Tendinitis

The Kurppa et al. [1991] study determined exposure status of 83% of the cohort on October 2, 1982, and followed their health status until April 30, 1985. The remaining subjects entered the study when they became permanent employees, and were also followed until April 30, 1985.

Although the remaining studies that addressed force were cross-sectional, the following information increases the likelihood that exposure to forceful work occurred before the occurrence of tendinitis: Bystrom et al. [1995] noted that subjects were selected for clinical examination 5 months after completion of questionnaires on exposure. McCormack et al. [1990] reported that the minimum average length of employment in the job categories studied was more than 7 years. Roto and Kivi's

[1984] subjects had all worked in the food industry for more than one year. Armstrong et al. [1987] required a minimum of 1 year of employment to be included in the study.

Consistency of Association—Force and Hand/Wrist Tendinitis

All of the studies reviewed reported positive RR estimates for hand/wrist tendinitis among occupational groups exposed to forceful exertions, ranging from 1.8 to 38.5. Four of the five studies reported statistically significant findings. If only statistically significant estimates from studies in which limitations were not noted are considered, RR estimates for force and hand/wrist tendinitis range from 2.5 to 3.1.

Coherence of Evidence—Force and Hand/Wrist Tendinitis

See Repetition Section

Evidence of a Dose-Response Relationship—Force and Hand/Wrist Tendinitis

Armstrong et al. [1987] demonstrated a dose-response relationship between jobs requiring forceful exertions and hand/wrist tendinitis. The estimate of RR for hand/wrist tendinitis among workers with jobs that were classified as HIGH FORCE & LOW REPETITION was 4.8 (0.6, 39.7), while the estimate for HIGH FORCE & HIGH REPETITION jobs was 17.0 (2.3, 126.2), compared to the comparison group of LOW FORCE & LOW REPETITION jobs.

Conclusions on Force and Hand/Wrist Tendinitis

There is **strong evidence** for an association between work that requires forceful exertions, in combination with other job risk factors, and hand/wrist tendinitis based on currently available epidemiologic data. All five of the studies reviewed reported data that resulted in positive RR estimates. Four of the five estimates were statistically significant. Eliminating one estimate of RR from a study with noted limitations that might bias the estimate upward does not change this conclusion. Potential confounders such as age and gender were examined in these studies (see discussion of potential confounders on page 16) and there was no evidence that reported associations were distorted by confounders.

POSTURE

Definition of Posture for Hand/Wrist Tendinitis

Kuorinka and Koskinen [1979] determined the time spent in deviated wrist postures per work cycle as part of their "workload index" that was used in a dose-response analysis within the exposed group. Comparison groups in the other studies were job categories; selection of the groups to be compared was based on observations, questionnaire data, or surveillance data.

Studies Reporting on the Association of Posture and Hand/Wrist Tendinitis

Four studies addressed posture: Amano et al. [1988]; Bystrom et al. [1995]; Luopajarvi et al. [1979]; and Kuorinka and Koskinen [1979].

Studies Meeting the Four Criteria

Luopajarvi et al. [1979] met all four evaluation criteria. Luopajarvi et al. [1979] compared the prevalence of hand/wrist tendinitis among 152 female assembly line packers in a food production factory to 133 female shop assistants in a department store. Exposure to repetitive work, awkward hand/arm postures, and static work was assessed by observation and videotape analysis of factory workers. No formal exposure assessment was conducted on the department store workers; their job tasks were described as variable. Cashiers were excluded, presumably because their work was repetitive. The health assessment consisted of interviews and physical examinations conducted by a physiotherapist (active and passive motions, grip-strength testing, observation, and palpation); and diagnoses of tenosynovitis and peritendinitis were later determined by medical specialists using these findings and predetermined criteria. The PR for tendinitis among the assembly line packers compared to the shop assistants was 4.13 (95% CI 2.63–6.49). Age, hobbies, and housework were addressed, and no associations with musculoskeletal disorders were identified.

Amano et al. [1988] reported the prevalence of cervicobrachial disorders, including tenosynovitis, among 102 assembly line workers in an athletic shoe factory and 102 age- and gender-matched non-assembly line workers (clerks, nurses, telephone operators, cooks, and key punchers). Exposure assessment was based on videotape analysis of the tasks of 29 workers on one assembly line. Characteristic basic postures were summarized by the investigators as: holding a shoe or a tool, extending or bending the arms, and keeping the arms in a certain position. Assembly line workers produced about 3,400 shoes a day. All but one task had cycle times less than 30 seconds. No formal exposure assessment of the comparison group was reported. Diagnoses were determined by physical examination, including palpation for tenderness. The PRs for tenosynovitis of the right and left index finger flexors among the shoe factory workers were 3.67 (95% CI 1.85–7.27) and 6.17 (95% CI 2.72–13.97) respectively, compared to the non-factory workers. Tenosynovitis of the other digits was not diagnosed in the comparison group. Shoe assembly workers held shoe lasts longer in the left hand and had greater frequency of symptoms in the left hand. Comparison subjects were matched to shoe factory workers on gender and age (within five years).

Bystrom et al. [1995] studied forearm and hand disorders among 199 automobile assembly line workers and compared them to 186 randomly selected subjects from the general Swedish population. For both groups, exposure was assessed using rating scales on nurse-administered questionnaires that addressed daily duration of hand and finger movements, wrist position, grip, and hand-tool use [Fransson-Hall et al. 1995]. Videotape analysis and electromyograms were conducted on a subgroup [Hagg et al. 1996]. A diagnosis of tenosynovitis or peritendinitis required the observation of swelling and pain during active movement on physical examination. A diagnosis of deQuervain's disease required a positive Finkelstein's test. No cases of tenosynovitis or peritendinitis, other than deQuervain's disease, were found in this study, probably because of strict clinical criteria used for the case definition. The PR for deQuervain's disease among the automobile assembly line workers was 2.49 (95% CI 1.00–6.23) compared to the general population group. Psychosocial variables and other potential confounders or effect modifiers were addressed by Fransson-Hall et al. [1995]. A higher prevalence of deQuervain's disease was noted among men than women.

Kuorinka and Koskinen [1979] studied occupational rheumatic diseases and upper limb strain among 93 scissor makers and compared them to the same group of department store assistants (n=143) that Luopajarvi used as a comparison group. Temporary workers and those with recent trauma were excluded from the scissor makers group. Exposure assessment included videotape analysis of scissor maker tasks. The time spent in deviated wrist postures per work cycle was multiplied by the number of pieces handled per hour and the number of hours worked to create a workload index. Cycle times ranged from 2 to 26 seconds; the number of pieces handled per hour ranged from 150 to 605. No formal exposure assessment was conducted on the shop assistants. Health assessment involved interview and physical examination by a

physiotherapist following a standard protocol. Diagnoses of tenosynovitis and peritendinitis were later determined from these findings using predetermined criteria (localized tenderness and pain during movement, low-grip force, swelling of wrist tendons [Waris 1979]). In equivocal cases, orthopedic and physiatric teams determined case status. The PR for muscle-tendon syndrome among the scissor makers as 1.38 (95% CI 0.76–2.51) compared to the department store assistants. Whether or not cashiers were excluded from the comparison group in this study, as they were in the Luopajarvi et al. study is unclear. The study group was 99% female. No relation-ship was found between age or body mass index and muscle-tendon syndrome. The number of symptoms increased with the number of parts handled per year. Analyses of subgroups of scissor makers showed non-significant increased prevalence of muscle-tendon syndrome in short versus long cycle tasks and in manipulation versus inspection tasks. The authors noted a lack of contrast in exposures between the subgroups. A non-significant trend of increasing prevalence of diagnosed muscle-tendon syndrome with increasing number of pieces handled per year was noted in a nested case-control analysis (n=36).

Strength of Association—Extreme Posture and Hand/Wrist Tendinitis

The PRs for extreme postures and hand/wrist tendinitis ranged from 1.4 to 6.2. All of the PRs were greater than one and three of the four studies reported statistically significant estimates. As noted in the Repetition section, the possibility of examiner bias might exist in the study reported by Amano et al. [1988], potentially biasing the RR estimate upward. The middle of the range of statistically significant estimates for RR for hand/wrist tendinitis is 2.5 to 4.1.

Temporal Relationship

Although all of the studies reviewed in this section were cross-sectional, at least two of the studies addressed temporality by reporting a minimum length of employment (Luopajarvi et al. [1979] - 5 years) or by evaluating exposure before health outcomes [Bystrom et al. 1995], as discussed in the previous sections on Repetition and Force.

Consistency

All of the studies reviewed showed positive RR estimates for hand/wrist tendinitis among occupational groups exposed to extreme postures, ranging from 1.4 to 6.2. Three of the four studies reviewed resulted in statistically significant PRs. Considering only statistically significant estimates from studies not noted to have design limitations that might bias the RR, narrows the range to 2.5 to 4.1.

Coherence of Evidence
See Repetition Section

Dose-Response
See Repetition Section

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Posture and Hand/Wrist Tendinitis

PR and 95% CI	Authors	Exposed / Unexposed Groups
4.1 (2.6, 6.5)	Luopajarvi et al. [1979]	food packers / department store assistants
3.7 (1.9, 7.3) to 6.2 (2.7, 14.0)	Amano et al. [1988]	shoe assemblers / clerks, nurses, operators, cooks, keypunchers
2.5 (1.0, 6.23)	Bystrom et al. [1995]	auto assemblers / general population
1.4 (0.8, 2.5)	Kuorinka and Koskinen [1979]	scissor makers / department. store assistants

There is **strong evidence** for a positive association between work that requires extreme postures, in combination with other job risk factors, and hand/wrist tendinitis, based on currently available epidemiologic data. All of the studies reviewed reported data that resulted in positive RR estimates. Three of the four estimates from these studies were statistically significant. Taking into account the effect of potential confounders [See Repetition Section] such as gender, age, and study limitations does not alter this conclusion.

Potential Confounders

Gender

The association between gender and tendinitis is not uniform. Bystrom et al. [1995] reported a higher prevalence of deQuervain's tendinitis in men than in women, and proposed the explanation that men in their study group used hand tools more often than women. Ulnar deviation and static muscle loading were likewise more often reported among men. Armstrong et al. [1987] reported a higher prevalence of

tendinitis among women but found no significant associations with other medical factors or activities outside of work. However, significant differences in posture were observed between males and females. Differences in postures may be due to differences in height between men and women whose workstations have uniform dimensions. In McCormack et al.'s [1990] study of textile workers, three of the four exposed groups were largely female (89%–95%), limiting the ability to separate the effect of gender from job effect. However, in an analysis that included gender and job as risk factors, they reported that gender was a significant predictor of tendinitis (p=0.01), but not as significant a predictor as job category (p=0.001). The other studies reviewed did not have both male and female subjects.

Age

Several investigators noted that tendinitis appears to be more prevalent in younger age groups. Bystrom et al. [1995] reported that most of the cases of deQuervain's tendinitis occurred in the <40-yr. age group.

McCormack et al. [1990] reported that age was not a significant predictor of tendinitis, but years on the job was inversely associated—prevalence was higher if less than 3 years on the job. Armstrong et al. [1987] noted that "a significant interaction between sex, age, and years on the job suggested that the risk of hand/wrist tendinitis might actually decrease with an increased number of years on the job, but the effect was too small to merit further discussion." Roto and Kivi [1984] noted that "The few cases of tenosynovitis occurred in younger workers." Kuorinka and Koskinen [1979], and Luopajarvi et al. [1979] found no significant association between age and tendinitis.

Other Potential Confounders

McCormack et al. [1990] reported that race was not associated with tendinitis. Armstrong et al. [1987] found no significant associations with personal factors—birth control pills, hysterectomy, oophorectomy, recreational activities. No subjects with seropositive rheumatic diseases were included in the Kuorinka and Koskinen [1979] study. They reported that their earlier unpublished questionnaire found no correlations between illness and extra work, work outside the factory, work at home, or hobbies. Luopajarvi et al. [1979] excluded subjects with previous trauma, arthritis, and other pathologies.

There is no evidence in the studies reviewed here that the associations reported between work factors and hand/wrist tendinitis are distorted by gender, age, or other factors.

CONCLUSIONS

Eight epidemiologic studies have examined physical workplace factors and their relationship to hand/wrist tendinitis. Several studies fulfill the four epidemiologic criteria that were used in this review, and appropriately address important methodologic issues. The studies generally involved populations exposed to a combination of work factors; one study assessed single work factors such as repetitive motions of the hand. We examined each of these studies, whether the findings were positive, negative, or equivocal, to evaluate the strength of work-relatedness, using causal inference.

There is **evidence** of an association between any single factor (repetition, force, and posture) and hand/wrist tendinitis, based on currently available epidemiologic data. There is **strong evidence** that job tasks that require a combination of risk factors (e.g., highly repetitious, forceful hand/wrist exertions) increase risk for hand/wrist tendinitis.

Table 5b-1. Epidemiologic criteria used to examine studies of hand/wrist tendinitis associated with repetition

Study (first year and author)	Risk indicators (OR, PRR, IR or p-value)[*][†]	Participation rate ≥70%	Physical examination	Investigator blinded to case and/or exposure status	Basis for assessing hand/wrist exposure to repetition
Met all four criteria:					
Armstrong 1987	5.5, 17.0[†]	Yes	Yes	Yes	Observation or measurements
Luopajarvi 1979	4.1[†]	Yes	Yes	Yes	Observation or measurements
Met at least one criteria:					
Amano 1988	3.7–6.2[†]	NR[‡]	Yes	NR	Job titles or self-reports
Byström 1995	2.5[†]	Yes	Yes	NR	Job titles or self-reports[§]
Kuorinka 1979	1.4	Yes	Yes	NR	Observation or measurements
McCormack 1990	1.75	Yes	Yes	NR	Job titles or self-reports
Roto 1984	3.1[†]	Yes	Yes	NR	Job titles or self-reports

[*]Some risk indicators are based on a combination of risk factors—not on repetition alone (i.e., repetition plus force, posture, or vibration). Odds ratio (OR), prevalence rate ratio (PRR), or incidence ratio (IR).

[†]Indicates statistical significance.

[‡]Not reported.

[§]EMG and video analysis of subgroup reported in Hagg et al. 1996.

Figure 5b-1. Risk Indicator for "Repetition" and Hand/Wrist Tendinitis
(Odds Ratios and Confidence Intervals)

Kuorinka 1979

McCormack 1990

Bystrom 1995

Roto 1984

Luopajarvi 1979*

Armstrong 1987*

Amano 1988

(39.7)

*Studies which met all four criteria

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Table 5b-2. Epidemiologic criteria used to examine studies of hand/wrist tendinitis MSDs associated with force

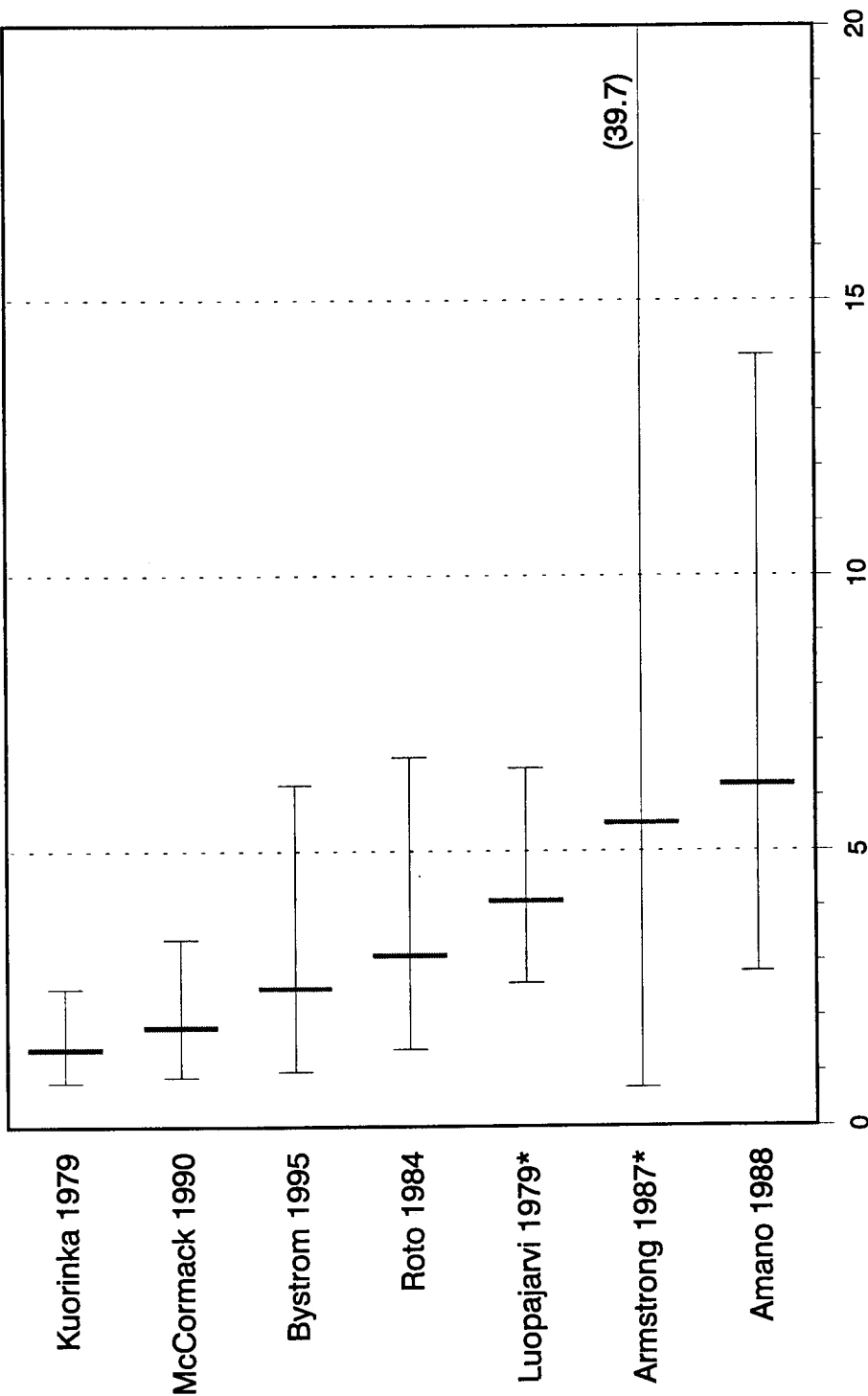| Study (first author and year)	Risk indicator (OR, PRR, IR or p-value)[*,†]	Participation rate ≥70%	Physical examination	Investigator blinded to case and/or exposure status	Basis for assessing hand/wrist exposure to force
Met all four criteria:					
Armstrong 1987	17.0[†], 4.8	Yes	Yes	Yes	Observation or measurements
Met at least one criteria:					
Byström 1995	2.5[†]	Yes	Yes	NR[‡]	Job titles or self-reports[§]
Kurppa 1991	14.0–38.5[†]	Yes	Yes	NR	Observation or measurements
McCormack 1990	3.0[†]	Yes	Yes	NR	Job titles or self-reports
Roto 1984	3.1[†]	Yes	Yes	NR	Job titles or self-reports

[*]Some risk indicators are based on a combination of risk factors—not on force alone (i.e., force plus repetition, posture, or vibration). Odds ratio (OR), prevalence rate ratio (PRR), or incidence ratio (IR).

[†]Indicates statistical significance.

[‡]Not reported.

[§]EMG and video analysis of subgroup reported in Hagg et al. 1996.

Figure 5b-2. Risk Indicator for "Force" and Hand/Wrist Tendinitis
(Odds Ratios and Confidence Intervals)

Bystrom 1995

McCormack 1990

Roto 1984

Armstrong 1987* (39.7)

Kurppa 1991 (34.4)

Armstrong 1987* (126.2)

*Studies which met all four criteria

5b-21

Table 5b-3. Epidemiologic criteria used to examine studies of hand/wrist tendinitis MSDs associated with posture

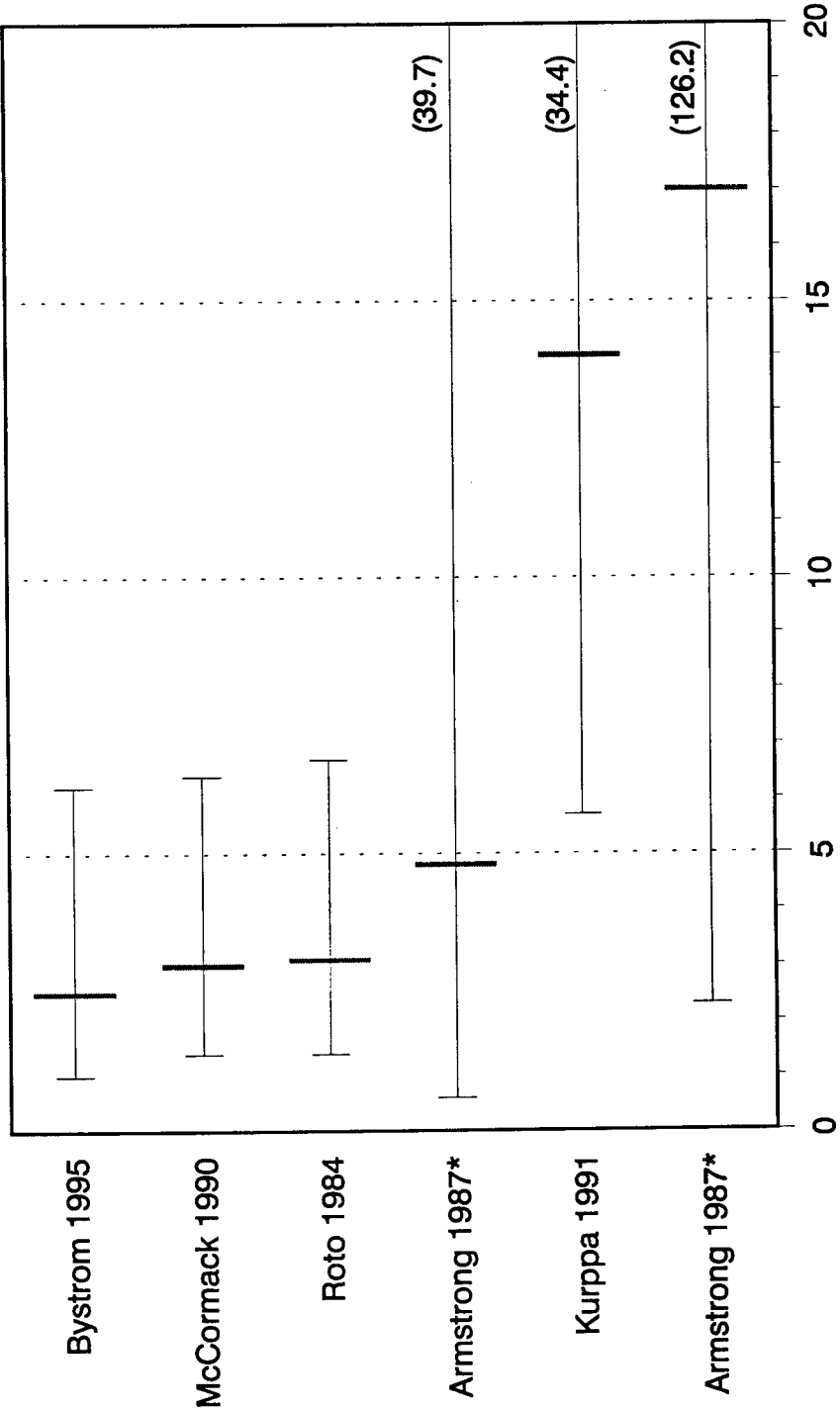| Study (first author and year)	Risk indicator (OR, PRR, IR or p-value)[*,†]	Participation rate ≥70%	Physical examination	Investigator blinded to case and/or exposure status	Basis for assessing hand/wrist exposure to posture
Met all four criteria:					
Luopajärvi 1979	4.1[†]	Yes	Yes	Yes	Observation or measurements
Met at least one criteria:					
Amano 1988	3.7–6.2[†]	NR[‡]	Yes	NR	Job titles or self-reports
Byström 1995	2.5[†]	Yes	Yes	NR	Job titles or self-reports[§]
Kuorinka 1979	1.4	Yes	Yes	NR	Observation or measurements

[*]Some risk indicators are based on a combination of risk factors—not on posture alone (i.e., posture plus force, repetition, or vibration). Odds ratio (OR), prevalence rate ratio (PRR), or incidence ratio (IR).

[†]Indicates statistical significance.

[‡]Not reported.

[§]EMG and video analysis of subgroup reported in Hagg et al. 1996.

5b-22

Figure 5b-3. Risk Indicator for "Posture" and Hand/Wrist Tendinitis
(Odds Ratios and Confidence Intervals)

*Studies which met all four criteria

5b-23
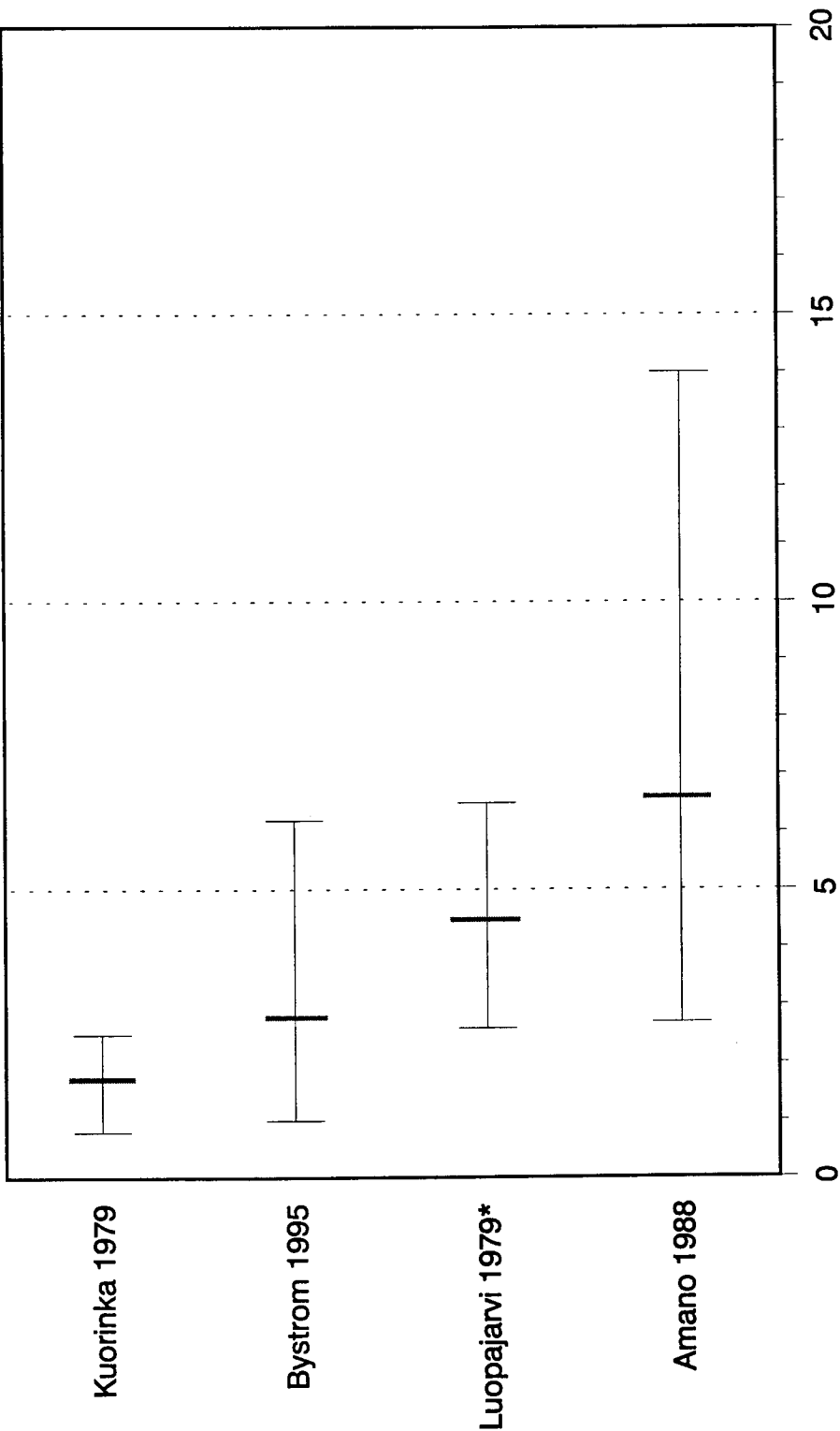
Table 5b–4. Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence				Comments
				Exposed workers	Referent group	RR, OR, or PRR	95% CI	
Amano et al. 1988	Cross-sectional	102 assembly line workers in an athletic shoe factory compared to 102 age and gender matched non-assembly line workers (clerks, nurses, telephone operators, cooks, and key punchers).	Outcome: Examination by a physician: palpation for tenosynovitis and tenderness. Exposure: One line of 29 shoe assembly workers was selected for job analysis. Videotapes were evaluated for movements of the upper extremities and shoulders and cycle and holding times. No formal exposure assessment of comparison group.	Tenosynovitis, right index finger flexors: 32.35% Tenosynovitis, left index finger flexors: 36.27%	Tenosynovitis right index finger flexors: 8.82% Tenosynovitis left index finger flexors: 5.88%	PR = 3.67 PR = 6.17	1.85-7.27 2.72-13.97	Participation rate: Not reported. Unclear whether examiner was blinded to job category (occupational groups examined on separate dates). No clear case definition provided. Potential for examiner bias exists. Comparison group was matched in gender and age (within 5 years). Tenosynovitis of other digits was not diagnosed in the comparison group. Neurological exam and clinical tests of pinch strength, tapping, pressure, and vibration sensibility were also done. No significant differences between groups in finger-pinch strength. Shoe workers failed the tapping test more often, had lower pressure-sensibility in 1 of 10 fingers tested, and had lower vibration-sensibility in 2 of 10 fingers. One of 3 neurological maneuvers (Morley's test) was more often positive in shoe workers. Exposure to toluene is noted and is a potential confounder for neurological findings. Assembly line workers produced about 3,400 shoes a day. All but one task had cycle times < 30 sec. Assembly workers held shoe lasts longer in the left hand and had greater frequency of symptoms in left hand vs. non-assembly workers, who were assumed to use right hand (dominant hand) more frequently.

5b-24

(Continued)

Table 5b-4 (Continued). Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence				Comments
				Exposed workers	Referent group	RR, OR, or PRR	95% CI	
Armstrong 1987	Cross-sectional	652 industrial workers divided into 4 groups: (1) Low force, low repetition (comparison group, N=157), (2) High force, low repetition (N=195), (3) Low force and high repetition (N=143), and (4) High force and high repetition (N=157).	Outcome: Positive findings on interview and physical exam were required for case definition. Tendinitis/teno-synovitis: localized pain or swelling lasting > a week, and increased pain with resisted but not passive motion. Trigger finger: locking in extension or flexion and a palpable nodule at base of finger. DeQuervain's: positive Finkelstein test with localized pain score of > =4 (range 1 to 8). Exposure: To force and repetition assessed by EMG and video analysis of jobs performed by a sample of workers.	3.1% (Group 2) 3.5% (Group 3) 10.8% (Group 4)	0.6%	4.8 5.5 17.0	0.6-39.7 0.7-46.3 2.3-126.2	Participation rate: 90% of workers originally selected for inclusion actually participated. The effect of age, gender, years on the job, and plant were analyzed. Higher prevalence of tendinitis among women, but not significantly associated with personal factors. Significant differences in posture were observed between males and females. Examiners were blinded to exposure status of study participants.

5b-25

Table 5b-4 (Continued). Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence				Comments
				Exposed workers	Referent group	RR, OR, or PRR	95% CI	
Byström et al. 1995	Cross-sectional	199 automobile assembly line workers, compared to 186 general population.	Outcome: Tenosynovitis or peri-tendinitis were diagnosed based on physical examination observations: swelling and pain at the tendon sheath, peri-tendinous area or muscle-tendon junction during active movement of the tendon. DeQuervain's tendinitis: Positive Finkelstein's test. Exposure: Daily duration of hand and finger movements, manual handling, wrist position, grip type, and hand-tool use were rated by workers on 6-point scales in questionnaires (Fransson-Hall et al. 1995). Forearm muscular-load and wrist angle were evaluated by EMG and videotape analysis for a subgroup (Hagg et al. 1996).	8.04% (deQuervain's tendinitis)	3.23%	2.49	1.00-6.23	Participation rate: 96%. Study group randomly selected from assembly division of a plant. Comparison group is from the MUSIC study (Hagberg and Hogstedt 1991). Examiners blinded to exposure status: no, everyone examined by the authors was in the exposed group. Results are reported separately for males and females, and for age <40 years. Psychosocial variables and other potential confounders or effect modifiers were addressed by Fransson-Hall et al. 1995. Higher prevalence of deQuervain's tendinitis in males than in females–possibly related to greater use of hand tools, ulnar deviation, and/or static muscle loading. No cases of tenosynovitis or peritendinitis were found in this study, probably because of strict clinical criteria (required observation of swelling).

5b-26

(Continued)

Table 5b-4 (Continued). Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence				Comments
				Exposed workers	Referent group	RR, OR, or PRR	95% CI	
Kuorinka and Koskinen 1979	Cross-sectional	93 scissor makers compared to 143 shop assistants. First Phase: physical examination and interview. Phase Two: work analysis. 10-month interval between phases. Comparison group was from another study that used the same method (Luopajarvi et al. 1979).	Outcome: Tenosynovitis and peritendinitis diagnosed by interview and physical exam. Physiotherapist examined workers, diagnoses were from predetermined criteria (Waris 1979: localized tenderness and pain during movement and low grip-force and swelling of wrist tendons). In problem cases orthopedic and physiatric teams determined case status. Exposure: Work history, hr, and production rates for the previous year were taken from company records. A workload index was based on videotape analysis of scissor maker workstations: time spent in deviated wrist-posture (>20°)/work cycle; multiplied by number pieces handled multiplied by hr worked. No exposure assessment of shop assistants.	18.3%	13.5%	1.38	0.76-2.51	Participation rate: 81%. Examiner was not blinded to case status, but diagnosis was made separately, using predetermined criteria (Waris et al. 1979). Study group was 99% female. No relationship found between age or body mass index and "muscle-tendon syndrome." The number of symptoms increased with the number of parts handled/year. Workers were paid by piece rate. Within the group of scissor makers, non-significant increased prevalences of muscle-tendon syndrome in short vs. long cycle tasks and in manipulation vs. inspection tasks was reported. The authors noted a lack of contrast in exposures between the subgroups. A non-significant trend of increasing prevalence of diagnosed muscle-tendon syndrome with increasing number of pieces handled/year was noted in a nested case-control analysis (n=36).

5b-27

(Continued)

Table 5b–4 (Continued). Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence				Comments
				Exposed workers	Referent group	RR, OR, or PRR	95% CI	
Kurppa et al. 1991	Cohort: 31 month follow-up	377 meatcutters, meat packers and sausage makers compared to 388 office workers, maintenance workers, and supervisors.	Outcome: Defined as physician-diagnosed tenosynovitis or peritendinitis of the hand or forearm. Criteria were swelling or crepitation and tenderness to palpation along the tendon and pain at the tendon sheath, in the peritendinous area, or at the muscle-tendon junction during active movement of the tendon. DeQuervain's tendinitis: positive Finkelstein's test (if not positive, included in tendinitis group). 25% of diagnoses made by physicians outside plant, criteria unknown. Exposure: Job categories selected based on whether or not strenuous manual work was required. Exposure data obtained from previous published literature and plant walk-throughs.	12.5/100 person years (meatcutters) 25.3/100 person years (meat packers) 16.8/100 person years (sausage makers)	0.9/100 person years (Males) 0.7/100 person years (Females)	14 (meat-cutters) 38.5 (meat packers) 25.6 (sausage makers)	5.7-34.4 11.7-56.1 19.2-77.5	Participation rate: >70%. Job transfers and employee termination followed up with questionnaire. Questionnaire response rate over 70%. Exposed and comparison groups were similar in age and gender mix, although gender varied with job. If same diagnosis occurred at same site in worker after 60 days, it was considered new episode. Therefore, separate episodes may be recurrences, and thus influence results. Median interval of 233 days between episodes. Packers worked in temperatures 8° to 10°C; sausage makers worked in temperatures 8° to 20°C. Examiners were not blinded to occupation of subjects. Plant selected because of high number of reports of musculoskeletal disorders. All permanent workers in meat cutting, sausage making and packing departments were included, after 3 months of work. Case ascertainment: Workers in non-strenuous jobs may not have sought medical care for MSDs since they might still be able to perform their jobs.

5b-28

(Continued)

Table 5b–4 (Continued). Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence				Comments
				Exposed workers	Referent group	RR, OR, or PRR	95% CI	
Luopajärvi et al. 1979	Cross-sectional	152 female assembly line packers in a food production factory were compared to 133 female shop assistants in a department store. Cashiers were excluded from comparison group.	Outcome: Tenosynovitis and peritendinitis diagnosed by interview and physical exam. Physiotherapist performed active and passive motions, grip strength tests, observation and palpation. Medical specialists used these findings later to diagnose disorders using predetermined criteria (Waris 1979). Exposure: Exposure to repetitive work, awkward hand/arm postures, and static work assessed by observation and video analysis of factory workers. No formal exposure assessment of shop assistants.	55.9%	13.5%	PR = 4.13	2.63-6.49	Participation rate: 84%. Workers excluded from participation for previous trauma, arthritis and other pathologies. Examiner blinded to case status: Not stated in article. No association between age and MSDs or length of employment and MSDs. Factory opened only short time. Hobbies and housework were not significantly associated with outcome. Unable to examine effect of job-specific risk factors because of job rotation.

5b-29

Table 5b-4 (Continued). Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence Exposed workers	MSD prevalence Referent group	RR, OR, or PRR	95% CI	Comments
McCormack et al. 1990	Cross-sectional	Textile workers: 4 broad job categories involving intensive upper extremity use–sewing (n = 562), boarding (n = 296), packaging (n = 369), and knitting (n = 352); compared to other non-office workers (n = 468), including machine maintenance workers, transportation workers, and cleaners and sweepers.	Outcome: Assessed by questionnaire and screening physical exam, followed by diagnostic physical examination. Tendinitis: Positive physical findings suggestive of inflammation. Severity reported as mild, moderate or severe. Exposure: To repetitive finger, wrist and elbow motions based on knowledge of jobs; no formal exposure assessment performed.	boarding: 6.4% sewing: 4.4% packaging: 3.3% knitting: 0.9% Overall Exposed Group: 3.75%	other non-office: 2.1%	3.0 2.1 1.5 0.4 1.75	1.4-6.4 1.0-4.3 0.7-3.5 0.1-1.4 0.9-3.39	Participation rate: 90.5% for screening; 93.6% of those screened went on to complete physical examination. Stratified random sampling within occupational groups. Not mentioned whether examiners blinded to exposure status (job category). Prevalence higher in workers with <3 years of employment. Race and age not related to outcome. Female gender was a significant predictor of tendinitis (p = .01), but job category was a stronger predictor (p = .001). 10/12 Physician examiners recorded diagnoses within 12% of the mean for the group. 47.9% of workers who had either positive screening physical exams or reported symptoms on questionnaire were diagnosed with tendinitis or tendinitis-related syndromes.

5b-30

Table 5b-4 (Continued). Epidemiologic studies evaluating work-related hand/wrist tendinitis

Study	Study design	Study population	Outcome and exposure	MSD prevalence				Comments
				Exposed workers	Referent group	RR, OR, or PRR	95% CI	
Roto and Kivi 1984	Cross-sectional	90 meatcutters compared to reference group of 72 construction foremen who had not been exposed to repetitive movements of the upper extremities in their work. All participants were male.	Outcome: Tenosynovitis defined as swelling, local pain and finger weakness during movement (determined by questionnaire and physical exam). Exposure: Based on job title. Study groups were selected based on general knowledge of job tasks: meatcutters' work entailed physical exertion of upper extremities and shoulders. Construction foremen's work did not involve repetitive movements of the upper extremities. No formal exposure assessment.	4.5% Symptom prevalence rate: 30.0%	0.0% Symptom prevalence rate: 10.0%	Indeterminate 3.09	— 1.43-6.67	Participation rate: 100% for meatcutters, 94% for comparison group. Authors state that examiners were blinded to occupation of subjects because part of larger group of meat processing workers examined, but it is unclear whether construction foremen (referents) were examined separately. Serologic testing for rheumatoid arthritis was done to control for potential confounding (none detected). Relatively strict diagnostic criteria used to avoid false positive cases. Authors note that tenosynovitis occurred in younger age groups. Although the only diagnosed cases of tenosynovitis occurred in the meatcutters (none in the referents), the authors were reluctant to infer association with meatcutting because of the relatively low prevalence rate (4.5%).

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